

DOCUMENT RESUME

ED 479 587

IR 022 191

AUTHOR Muhlhauser, Max; Trompler, Christoph
TITLE Digital Lecture Halls Keep Teachers in the Mood and Learners in the Loop.
PUB DATE 2002-10-00
NOTE 9p.; In: E-Learn 2002 World Conference on E-Learning in Corporate, Government, Healthcare, & Higher Education. Proceedings (7th, Montreal, Quebec, Canada, October 15-19, 2002); see IR 022 093. Figure contains illegible type.
AVAILABLE FROM Association for the Advancement of Computing in Education (AACE), P.O. Box 3728, Norfolk, VA 23514. Tel: 757-623-7588; e-mail: info@aace.org; Web site: <http://www.aace.org/DL/>.
PUB TYPE Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE EDRS Price MF01 Plus Postage. PC Not Available from EDRS
DESCRIPTORS *Computer Assisted Instruction; Computer Mediated Communication; *Distance Education; Electronic Classrooms; Higher Education; Instructional Development; Nontraditional Education; Teaching Methods
IDENTIFIERS *Digital Technology; Learning Communities

ABSTRACT

In the transition from traditional teaching and learning to eLearning, the authors advocate avoiding disruptive approaches. The authors claim that many virtual university and corporate university efforts worldwide try to showcase big leaps forward, yet lack sustainability, suffer from in-vitro conditions, and leave behind the big mass of teachers. The Digital Lecture Halls (DLH) project accommodates traditional teaching and learning styles, making them digitally available for computer assistance. It also reaches out to a large variety of computer-assisted methods and to accompanying new organizational and business models. Apart from this non-disruptive approach, DLH also focuses on large venues. In contrast to known electronic classroom efforts that are limited to about 25 local participants, audiences without size limits are supported in DLH. The first implementations support 150 and 1000 participants. The paper describes the general DLH approach and architecture as well as details of the learners-in-the-loop components. (Contains 11 references.) (Author)

Digital Lecture Halls Keep Teachers in the Mood and Learners in the Loop

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL IN
MICROFICHE ONLY HAS BEEN GRANTED BY

G.H. Marks

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

28

Max Mühlhäuser
Telecooperation, Department of Computer Science
Darmstadt University of Technology
Germany
max@informatik.tu-darmstadt.de

Christoph Trompler
Computer Operations Group, Department of Computer Science
Darmstadt University of Technology
Germany
trompler@informatik.tu-darmstadt.de

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

This document has been reproduced as
received from the person or organization
originating it.

Minor changes have been made to
improve reproduction quality.

Points of view or opinions stated in this
document do not necessarily represent
official OERI position or policy.

Abstract: In the transition from traditional teaching and learning to eLearning, we advocate avoiding disruptive approaches. We claim that many virtual university and corporate university efforts worldwide try to showcase big leaps forward yet lack sustainability, suffer from in-vitro conditions, and leave behind the big mass of teachers. Our Digital Lecture Halls (DLH) project accommodates traditional teaching and learning styles, making them *digitally* available for computer assistance. It also reaches out to a large variety of computer-assisted methods and to accompanying new organizational and business models. Apart from this non-disruptive approach, DLH also focuses on large venues. In contrast to known *electronic classroom* efforts that are limited to about 25 local participants, audiences without size limits are supported in DLH. The first implementations support 150 and 1000 participants. The paper describes the general DLH approach and architecture as well as details of the learners-in-the-loop components.

Rationale

Despite great achievements demonstrated at AACE conferences and in *in-vitro* showcases, computer-assistance is not common in lecture halls and classrooms, except maybe for the replacement of overhead transparencies by beamers. In cases where computer-assistance has become a commodity, like at *Hi-Tech* companies, sophistication is rather low: Computer Based Training (CBT) and Web Based Training (WBT) resemble behaviorist computer assisted instructions of the mid sixties, tele-teaching lessons present only a peep show like view for remote spectators, and *virtual universities*, behind a shiny *welcome screen* facade, offer mostly on-line versions of lecture notes originally conceived as paper documents.

One might argue that continuous and tertiary education worldwide is currently faced with a race towards corporate and virtual universities. Politicians and managers seem to be delighted with the budget-relieving vision of virtual teachers that can be replicated by way of keystrokes. However, looking at the continuation of many virtual university start-ups founded out of traditional university structures reveals some basic problems. The development efforts for suitable course material are tremendous for the virtual university set-up. Further, educators accustomed to on-site lecturing and contact to their students must realize that in distance education they face a different relationship with their students, requiring a different teaching and tutoring style to achieve success. As a consequence, we propose to avoid leapfrogging from real to virtual universities. Rather, we suggest a smooth transition that starts with the current and well-understood real universities. By augmenting current teaching venues with new technology, these teaching venues become digital (*electronic*) classrooms, Digital Lecture Halls (DLH), and virtual laboratories. Among these three, the present paper concentrates on Digital Lecture Halls since both electronic classrooms and virtual laboratories on the Internet are investigated in other projects. To the knowledge of the authors, no project concerning Digital Lecture Halls and e-classrooms, has addressed venues of large size, i.e. lecture halls for hundreds of learners.

Apart from addressing a new level of venue size, our approach is also novel as it is non-disruptive. The move from *analog* to *digital* teaching imposes as little as possible an adaptation for both teacher and learner in terms of

teaching and learning methods and styles. Hence, the digital lecture halls proposed here remain physical venues – distribution and virtuality is not an immediate goal. They even accommodate teachers who want to continue scribbling proofs or discourses by chalk and who are used to filling an entire handful of subsequent blackboards with a single proof or discourse. Finally, they offer *after hours* availability of such traditional lectures as a first noticeable improvement over traditional teaching and learning models. We will show that making this ‘hardly noticeable’ analog-to-digital move requires considerable yet feasible investment. The return on investment is unprecedented: instead of addressing only small elites of teachers, we emphasize changes for the masses.

One may ask whether a ‘hardly noticeable’ change is worth the effort in the first place. The answer is twofold: it is only the border of a continuous spectrum and being so simple, it can reach the masses instead of the elite. The remainder of this paper will show that the DLH concept accommodates all types of teaching methods: synchronous and asynchronous, local and distributed, strongly guided up to open explorative teaching methods. The difference is that by setting the entry threshold low for ordinary teachers, we intend to motivate nearly all teachers to enter the digital era. Also, the variety of computer-assisted teaching methods can be introduced at an individual pace and based on the experiences gained along the road – a policy which we claim to be indispensable, if the fast-moving computer and networking technology and the slower-moving *teaching culture* (pedagogy, didactics, and instructional sciences) are to be synchronized. By gradually adapting pedagogic and didactic concepts to the improved possibilities, the evolution process can keep pace with urgently needed feedback and evaluation. Such a smooth transition may include the following intermediate steps, each of which represents a computer-aided teaching set-up in its own rights:

1. *DigiMax*: Computer-augmented frontal teaching is immediately available in the digital venues (same-time / same-place), providing a *digital audimax* (DigiMax) setting in the DLH.
2. *LearnerLoop*: Cooperative learning can be introduced by offering mobile computing solutions for the learners in the audience owning portable devices.
3. *AfterHours*: Asynchronous rehearsal is the first immediate gain if streaming servers are added and lectures are kept on-line for a reasonable time.
4. *NetExL*: by hooking the digital venue onto the Internet in synchronous live mode, both remote humans (for example guest expert teachers) and remote bits (data such as Web sites, code such as simulations, virtual Internet labs, etc.) become available. Distributed DLHs can be created by mirroring the digital venue, allowing distributed classes to take courses. As streaming and multicast support are added, individual distance learners may join in.
5. *CourseLine*: Taking different kinds of recordings (see below) as raw material, the AfterHours level of different-time/different-place learning can be extended: Raw material can be post-authored into valuable course material for rehearsal and/or self-paced learning.

These steps are realized as different yet integrated components of the DLH hardware/software, each in turn consisting of several subcomponents. The detailed description of the steps will form the rest of the paper.

The Digital Lecture Hall

This section describes the design and implementation of the Darmstadt Digital Lecture Halls. The description follows the possible evolutionary steps, and hence, the above-mentioned components, that lead smoothly from *traditional teaching going digital* to different kinds of Internet/computer-assisted teaching. In Figure 1, these steps are related to a taxonomy of computer-supported cooperative learning (CSCL), showing that DLH covers all relevant areas of CSCL.

A coarse architectural description of DLH is depicted in Figure 2. It shows three basic layers of DLH, namely, hardware, components, and content (course material). The description will be extended only in the context of corresponding software functions. Among these, DigiMax is not only the first step of DLH’s use, it is also the glue for further components. In particular, most LearnerLoop functions are directly related to DigiMax subcomponents, and AfterHours is an extension of DigiMax for recording. NetExL extends the reach of DigiMax over the network and CourseLine accesses all other components. Figure 2 also depicts a learner management system (LMS) (Hornung & Hornung 1999). Core LMS functions like network access and group support during a lecture are realized as part of the project. Additional LMS functions are external to the DLH project. DLH is prepared for integration with an external LMS.

The next four sections follow the stepwise approach of DLH components and provide more details about the respective subcomponents and functionality.

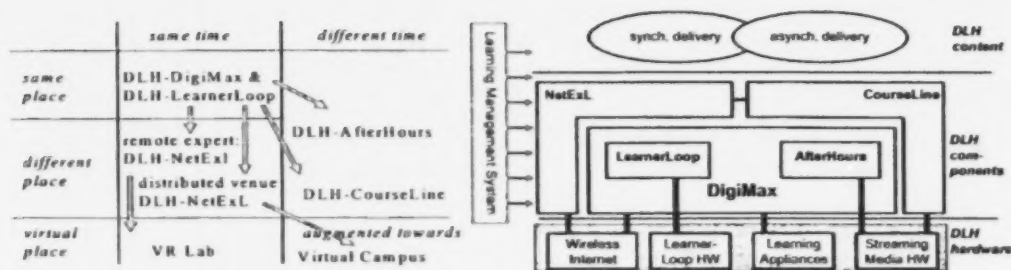


Figure 1. (left) DLH components related to CSCL taxonomy

Figure 2. (right) Coarse DLH architecture

DigiMax: Traditional Teaching Goes Digital

DigiMax realizes those computer-assisted features of a large-size auditorium that are related to the tasks of the lecturer. Therefore, minimal task change and minimal cognitive overhead are the key requirements for lecturers making the *analog-to-digital move*. Lecturers already accustomed to computer-based teaching, on the other hand, should find maximum support for their advanced needs. DigiMax consists of several software modules and supports flexible orchestration of numerous electronic lecture appliances and general-purpose hardware local to a lecture hall.

Virtual Multi Board: From the instructors' point of view, the main software module is the Virtual Multi Board (VMB). It is the only visible interface to other subcomponents like ScreenRecorder, RoomControl or LocalLectureLoop Applications.

Yet the VMB is not only a control interface. Major features are inspired from traditional *analog* use of lecture halls – following the major DLH goal to assimilate analog forms as much as possible. In traditionally large audiences, lecturers will not use a single blackboard. For instance, university lecturers teaching mathematics consume a handful of blackboards for a single proof. These multiple blackboards are usually visible to the audience at the same time. Even for a more loose related series of blackboards, it is a key feature of the *teaching technology* that several blackboards in the history remain visible: both to quickly review this history (to considerably improve retention rates) or as a buffer mechanism when learners lag behind with their note taking or re-reading. In order to support this *teaching technology* on the digital side, the VMB can be configured to hold threads of blackboards from *history*, manage multiple threads in parallel and display them with a customizable layout on a seamless multi screen display provided by the DigiMax hardware (Figure 3). Part of the VMB display space may also be configured to hold the output of any other software such as the NetExL component which might project a remote expert, lab, or peer DLH or results from quizzes deployed with the LearnerLoop Assignment module.

VMB offers simultaneous use of multiple input stations. Our initial DigiMax hardware provides two stations: a whiteboard and a tablet. The 72" whiteboard is rear-projected and mounted in such a way that the auditorium has maximum visibility and the lecturer has easy access. The pen-based inductive tablet with rear display is positioned like an *analog* overhead projector. Using the tablet, the lecturer can more easily keep eye contact with the audience – a feature considered crucial by many teachers today and a main reason for many to move from blackboards to overhead projectors. Both stations can show the same or different presentation threads or show a composite view of threads and controls and other applications not meant for presentation to the auditorium, like online feedback captured with our local loop tools, presentation control and notes or room control.

ScreenRecorder: Many tele-teaching settings feature *electronic whiteboard software* that integrates recording functionality. Annotations made by the lecturer are recorded and can be played back during (asynchronous) rehearsal. Advanced settings also support slide presentations but require the presentations to be converted to an intermediate format, losing features of the native presentation system, for example animations in PowerPoint (see Lecturnity [www.lecturnity.de]). In our approach, recording is supported for arbitrary software. We can create snapshots as well as stream screen recordings at high frame rates. We can capture the live application, arbitrary animations, dynamically created output as well as output from remote software. Audio output is also captured. The snapshots are used by the VMB history functionality. The stream recordings are targeted for AfterHours and for ToGather, a tool part of the LearnerLoop.

BEST COPY AVAILABLE

Our annotation library supports ink as well as higher-level objects such as pointers, text and simple geometrics. We provide necessary bindings to make VMB and ScreenRecorder aware of underlying features of the attached appliances and the running presentation software. Different whiteboard input tools switch between annotation modes. Slide changes or animation steps in applications like PowerPoint signal events in ScreenRecorder to create dynamic index frames and snapshots. The slides text is exported on the fly and used for further indexing. We provide a COM and Java Library for integrators to make their applications aware to our system.

The DigiMax Software layer is flexible regarding the underlying hardware. Although the complete software can be installed on a laptop, we recommend using a stationary installation in a lecture hall, consisting of at least a dual-screen projection, rear-display tablet and a server holding core services and the presentation system.

Our initial DLH prototype in a Lecture Hall fitting 150 students has the two input stations described before and uses a 9x2.25m multi-screen projection with three projectors totaling a resolution of 3840x768 pixels. A Windows 2000 Server with an AGP- and an additional Quad-PCI-Graphics Card is used as the central server that drives all attached displays at once.

Currently, we are preparing a mobile DigiMax extension unit to be used for DigiMax enhanced lectures in a legacy lecture hall fitting 1000 students. We will augment the existing XGA projection with a digital sideboard of two stacked projectors and use a rear-display tablet as input station. The mobile unit will also hold hardware in use by other DLH Components.

Lecturers who need or want to use their own equipment (for example a laptop with a computer-specific license of software to be shown) can use a stand-alone version of ScreenRecorder on their computer to generate processable content for a stationary DigiMax and may use a web based interface to remotely access VMB functionalities.

LearnerLoop: integrating local learners

A major goal in DLH is the tight integration of learners into the digital teaching/learning process. This has been a goal in other projects as well, be it tele-teaching setups or electronic classrooms. DLH again emphasizes a smooth evolution and large venues in this context.

Tele-teaching setups usually support audio connections to learners for question-and-answer phases of the lecture. In this respect, the multiple pen-tilt-zoom (PTZ) cameras installed in DLH as well as the microphone / speaker installation – all described in the context of AfterHours and NetExL below – already provide a level of sophistication that goes beyond common approaches.

Ambitious electronic classroom projects have equipped learner workplaces with computers carefully designed for integration in the computer-assisted teaching process. Computer-equipped learner workplaces are central to DLH, but with three major differences:

Computer-equipped learner workplaces are supported and recommended, but not mandatory. Use of video/audio communication is offered as an alternative.

Our experience with the *Classroom-of-the-Future* in Linz (Mühlhäuser 1996) shows that computer-equipped learner workplaces may lead to learner distraction and social and cognitive disintegration of the class.

Quite often, the individual access and high degree of freedom provided by typical per-workplace user interfaces, together with the cognitive overhead and level of concentration required by that user interface, leads to a large number of individual *learning threads* among the students in class. For CSCW software and group meeting rooms, this observation (and other similar ones) has led to the recommendation to even avoid per-workplace computers. In our case, it has led to the *minimal distraction* requirement that materializes in the TVremote subcomponent of LearnerLoop described below.

In our vision of virtually every lecture hall of a university or organization being DLH-like, we imagine learners to come and go and to switch venues quite often. Given the high level of deployment of mobile computing equipment among today's and tomorrow's learners, it seems quite natural to support learner-owned equipment. This assumption has far-reaching consequences that set DLH apart from electronic classrooms. Four categories of learner devices are considered and reach from SmartPhones via PDAs and pen-based notebooks to laptops. Wireless connectivity is the only feasible connectivity approach (this approach scales up to an online campus vision where learners can access all kinds of resources on the move). The LearnerLoop has to accommodate with a broad performance range with respect to both the learner device and the communication bandwidth.

Regarding the hardware, the four device classes envisioned were mentioned above; the wireless networks currently supported are General Packet Radio Service (GPRS) and IEEE 802.11b wireless LAN (wLAN), to be complemented by a Personal Area Network (PAN) standard in the future. The LearnerLoop component

comprises the four major subcomponents TVremote, Assignment, ToGather and UpLoad, which we will now describe in turn.

TVremote: As the name suggests, TVremote provides minimal functionality for the learner to *control* the digital lecture taking place. Following the minimal distraction requirement, the functions are usually mapped onto soft keys of the device, so that *pressing a single key* suffices for operation. The main function of TVremote is *tagging*: by pressing a tag key on the device, a learner expresses particular interest in the current phase of the lecture. She may either mark the beginning and end of a relevant section or indicate interest in *what the lecturer just said / presented*. In the latter case, the marker is set slightly back in time. Technically speaking, such tagging results in an entry in the learner's personal annotation file which points at the audio/video/presentation recording (see AfterHours) centrally stored. In a future version of DLH, tagging will influence the *aging* process of the recording, depending for example on whether or not a learner copied the marked parts to her private workspace.

Another important TVremote function is *RaiseHand*, a function that queues the learner for question. The lecturer may (immediately or later) call upon the learner using corresponding DigiMax functions. In the latter case, DigiMax calls VMB to display the slide that was visible at the time of *hand-raising*. While hand-raising is supposed to lead to immediate reaction by the lecturer for smaller audiences and local-only lectures, delayed calling-upon for questions is assumed to be common for very large audiences and distributed lectures.

We also use TVremote to implement a simple on the fly evaluation function, where the students can indicate if the instructor is doing a good job concerning understandability and presentation speed.

Assignment: The Assignment subcomponent offers a standardized means for lecture-initiated interaction, task assignment, and exams. Questionnaires, assignments etc. are modeled by the system as computer-based forms. Customizing this model, the lecturer can employ online questionnaires and examinations during the lecture. These questionnaires can be simple yes/no questions or more complicated multiple choice, gap text, or free text question / answer forms. The lecturer may perform the evaluation right on the spot, defer it to a later time or delegate the work to tutors. Questionnaire access can be anonymous to facilitate participation of learners who are scared of contradicting the lecturer. Exams, on the other hand, are of course authenticated. A tamper-proof authentication for official exams is still under development with our IT security research group.

ToGather: For a higher level of learner involvement and for group work during lectures, we relax the *minimal distraction* requirement in the context of the ToGather subcomponent. This subcomponent targets laptops, pen-based computers and hybrids used by learners in the DLH. Learners have the possibility to form closed discussion groups to perform group annotation. Their devices receive a live stream from the lecturer's input, presentation and annotations via ScreenRecorder. Learners can annotate this stream and see the annotations of other group members. Since local storage can be limited or is often not properly secure (in terms of backup), annotations are also stored on a central server. The learner can recall his notes offline from his computer, for example on his way home in public transport. She can exchange her notes between other students, ad hoc between devices. If willing, she may also expose her notes over the AfterHours system.

Upload: To prevent misuse of the network infrastructure, DLH is equipped with a firewall, which is part of the DLH specific LMS and allows access to be configured to the exact needs of different lectures. In this context, the Upload component provides learners with the possibility to access third-party virtual lab software during the lecture, based on access rights granted by the lecturer. This mode of operation is only possible if the wireless network infrastructure is not a shared installation, for example a shared campus-wide network.

TVremote and Assignment: the underlying OCLI platform

TVremote and Assignment use a common architecture, called Open Client Lecture Interaction (OCLI) (Trompler et al. 2002) and one generic model, called eQuestionnaire (eQ). OCLI supports instructor-based definition, control, and assessment of eQuestionnaires, and learner-based filling-in and submission. eQ embraces a broad spectrum from personal highlighting, over voting to assignments distributed during or after lectures.

OCLI uses a web-based XML processing framework and supports learners with any wireless networked terminal device capable of running some sort of web browser. Devices currently in use are WAP phones, PDAs like PocketPCs and notebooks. The OCLI system can be accessed by web applications, too. ToGather integrates OCLI access into its user interface. OCLI consists of five major modules: ADMIN, CTRL, DISPLAY, CORRECT and SCORE.

ADMIN, the administrative component, is intended for instructor use before the lecture. Featuring hierarchical curriculum/lecture/lesson structures, it lets the instructor define eQuestionnaires based on a set of pre-defined set

of eQ-types (such as timestamp markers, Q&A, assignments, polls) and of answer types (such as multiple choice, free text, selection).

CTRL, the control component, is again mainly intended for instructor use. This component determines the dissemination and accessibility of eQs with respect to both the time period of availability and the authorized audience. For Q&A sessions, *CTRL* supports the instructor in queuing, displaying, calling-upon, and answering questions during the lecture.

DISPLAY is the display component. This module assures the translation of generic XML-based eQ definitions into terminal device specific formats (Figure 4). It provides the user interface to the learners. Learners may choose between an anonymous or authenticated mode, depending on the lecture's policy.

CORRECT takes over the assessment, evaluation, and correction of learner input to instructor-initiated eQs (such as assignments, polls, or exams). For self-assessment purposes, instructors can call upon the automatic correction features of *CORRECT*. For other cases, the module presents the learners' eQ replies to the instructor, supports their correction and optional annotations, and conveys the assessments back to the learners.

SCORE adds statistical and graphical evaluation for sets of filled-in eQs. These may be viewed by the instructor or the learners on their terminal device or viewed on the VMB.

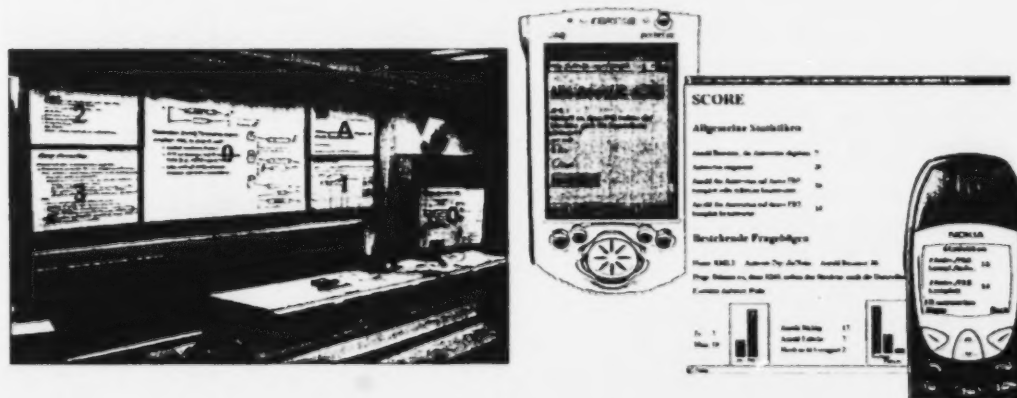


Figure 3. (left) Augmented photograph of DigiMax with VMB (0,1,2,3: thread with history, A: 2nd thread)

Figure 4. (right) OCLI: Assignment on different devices

AfterHours

AfterHours resembles the well-known lecture recording features for recalling the lecture after the sessions and before tests. This feature is found in many other distance learning and virtual university projects with a vast amount of tools available today. AfterHours approaches several issues we found especially important: Firstly, Multi Perspective Video, following observations first published by Jain and used in his MPIvideo products (Jain 1995). In contrast to common practice for tele-teaching, Jain advocates the use of multiple cameras. He refers to the cognitive process by which humans settle in an environment by subconsciously taking *snapshots* from different perspectives and view angles. Our current setups use two instructor and two audience cameras.

Secondly, automatic camera control and video composition, leveraging off an approach described in (Rui 2001). This eliminates the necessity of an assistant in charge of handling the multiple video streams and cameras.

Thirdly, we include student observations during and after recording to create a dynamic media repository. Students using TVremote to tag the lecture during the session can download compiled streams of the lecture containing only sections of interest. Tagging results can be shared in the same way as ToGather lecture notes. They are used for indexing and can be accessed together with the video and presentation recordings. A post-recording comment system is under development. Server access statistics and tagging results are used to garbage collect unused sections of the recordings.

BEST COPY AVAILABLE

NetExL and CourseLine

Since the NetExL and CourseLine components exist only in prototype versions, their description will be summarized here with a lesser degree of elaboration.

NetExL is currently realized as an outbound and an inbound subcomponent. The outbound subcomponent makes a live lecture recording available on the network. Corresponding to the available bandwidth of the remote site(s), several quality of service options exist. For high-bandwidth access on campus, the remote site receives all video streams and may interactively control the preferred camera stream. For lower bandwidth, either the main stream or no video stream at all may be selected. The inbound subcomponent places arbitrary inbound streams (camera input from remote experts, remote learners, or remote DLH sites) on a VMB sub-screen and optionally onto learner workplaces. Connections have to be manually set up requiring human intervention. This functionality must be augmented for further versions; for example as the lecturer calls upon learners for Q&A (either following a RaiseHand command or an Assignment based submitted question), she is to be auto-connected to the VMB remote-learner-sub-screen.

Within CourseLine, we explore two paths towards advanced teaching: starting from recorded lectures, furthering the above-mentioned authoring-on-the-fly approach and using the sophisticated DLH venue for a seamless introduction of advanced instructional strategies, like *Algorithm Animation* in computer science education (Rößling & Freisleben 2001).

Related approaches

Related work has been discussed in the course of this paper. A few general comparisons shall be added at this point, comparing DLH to electronic classrooms, virtual universities, and to tele-teaching efforts.

Of course, the project reported here is not the first digital teaching venue ever built. For comparable examples, see (Abowd et al. 1996) (Brown et al. 1998) (Ginsberg & Foster 1998) (Mühlhäuser 1996). However, other such venues were mostly built with only some of the above-mentioned milestones in mind. Even very advanced projects such as *Classroom 2000* at GeorgiaTech or the *Classroom-of-the-Future* project at the Ars Electronica Center in Linz, are restricted to classroom size around 25 participants.

However, some key goals and concepts of these electronic classroom projects are common with those of DLH. As a consequence, tools developed in the context of these projects partially resemble those presented in this paper. As discussed, major differences between electronic classroom tools and DLH tools for synchronous delivery are the interactive presentation support through the advanced possibilities of VMB and the learner integration via the Learner Loop Software.

Virtual universities have been mentioned several times in the present paper. DLH was positioned as an alternative approach in the sense that a smooth path from current to *digital* universities was proposed in contrast to the *leap* into virtual venues. At this point, it should be added that no commonly agreed definition of virtual universities exists and that other terms such as *corporate university* and *virtual campus* are used with overlapping meaning. Some of the corresponding projects concentrate on organizational and management issues, the technical aspects of these are largely addressed by learner management systems like WebCT (www.webct.com). Most virtual university projects offer on-line material for self-paced training – few of them go far beyond on-line versions of the lecture notes and/or classroom teaching material.

Lecture halls have been augmented with networking and computing equipment for tele-teaching. Among the many setups and projects worldwide, only a few are directly related to computer-assisted learning research and development activities like the activities at the Universities of Mannheim and Freiburg (Hilt et al. 2001). The work of these has brought forth a noticeable requirements document contrasting the status and vision of tele-teaching (Hilt & Kuhmünch 1999). This work also includes a description of the major scenarios to be supported, called *remote lecture room*, *remote interactive seminar*, *interactive home learning*, and *individual learning with CBT*. The overlap of these goals and concepts with the DLH project are obvious, yet these projects have different foci, mainly the support of large remote groups via sophisticated multicast and adaptive video, and the furthering of interactive whiteboard software. Such aspects at the core of computer-science related tele-teaching research, are of course relevant for DLH, but not considered the primary focus. Rather, DLH concentrates on issues such as large projection and intuitive (multiple input station based) input, minimal distraction and ease-of-use, and maximum tele-presence – as discussed in more detail above.

In summary, the research domains discussed in this chapter are complementary to DLH in their focus. Although they even have a different world view, all of them can be regarded as steps in the evolutionary process of digital lecturing proposed by DLH.

Lessons learned and summary

Despite the many virtual university and tele-teaching projects worldwide, many issues have yet to be resolved and many leapfrogging attempts may be questioned regarding their sustainability and effect on the masses. The Digital Lecture Hall project described takes a stepwise approach and offers an easy start for the average teacher and learner with virtually no need for behavioral change and with minimal cognitive overhead. The paper has introduced the major components that support stepwise sophistication, called DigiMax, LearnerLoop, AfterHours, NetExL, and CourseLine. We have shown how major known teaching and learning approaches can be accommodated by DLH.

Prototypes of DLH have been in use since summer 2001. There have been quite a number of concerns that the very low entry threshold for lecturers might be a temptation not to change the teaching process at all. These concerns did not turn out to be justified: average lecturers quickly learn to appreciate the additional possibilities offered by a digital environment. They will not switch to a different technology for technology's sake or by curiosity, such as the elite gathered in virtual university projects. This supports the basic assumption of DLH: virtual university projects are still too much *in vitro*, and teaching will only change on the large scale in the pace dictated by pedagogic and didactic improvements.

All in one, the first lessons learned strongly support the assumptions made at the outset of the DLH project.

References

- Abowd, G., & Atkeson, C. G., & Feinstein A., & Hmelo C., & Kooper R., & Long S., Sawhney N., & Tani M. (1996). Teaching and learning as multimedia authoring: the classroom 2000 project. *International Multimedia Conference*. Association for Computing Machinery. pp. 187-198.
- Brown, D., & Burg, J. J., & Dominick J. L. (1998). A strategic plan for ubiquitous laptop computing; *Communications, Vol (41)1*. Association for Computing Machinery. pp. 26 - 35.
- Ginsberg, R., & Foster, K. (1998). The Wired Classroom. *Spectrum, August 1998*. IEEE. pp. 44-51.
- Jain, R., & Wakimoto, K. (1995). Multiple Perspective Interactive Video. *Intl. Conf. Multimedia Computing & Systems, 1995*. IEEE Computer Society. pp. 202-211.
- Hilt, V., & Kuhmünch, C. (1999). New Tools for Synchronous and Asynchronous Teaching and Learning in the Internet. *ED-MEDIA and ED-TELECOM*, Seattle, USA. Association for the Advancement of Computing in Education.
- Hilt, V., & Mauve M., & Vogel J., & Effelsberg W. (2001). Interactive Media on Demand: Generic Recording and Replay of Interactive Media Streams. *International Multimedia Conference*. Association for Computing Machinery. pp. 593-594.
- Hornung, C., & Hornung, J. (1999). Knowledge Management in Learning Organizations, *19th World Conference on Open Learning and Distance Education*. Vienna.
- Mühlhäuser, M. (1996). Interdisciplinary Development of an Electronic Class and Conference Room. *Journal of Universal Computer Science 2 (10)*, Springer Heidelberg. pp. 694-710.
- Rui, Y., & He, L., & Gupta A., & Liu, Q. (2001) Building an intelligent camera management system. *International Multimedia Conference*. Association for Computing Machinery. pp. 2-11.
- Röbling, G., & Freisleben, B. (2001). ANIMALSCRIPT: An Extensible Scripting Language for Algorithm Animation. *32nd Technical Symposium on Computer Science Education*, Association for Computing Machinery. pp. 70-74.
- Trompler, C., & Mühlhäuser, M., & Wegner W. (2002). Open Client Lecture Interaction: An Approach to Wireless Learners-in-the-Loop. *4th International Conference on New Educational Environment*. Section 3.1, pp. 43-46.



*U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)*



NOTICE

Reproduction Basis

- ☒ This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.
- ☐ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").